Lifescan USB Cable

Design Document

(Description of Circuit Function)

Introduction

1.1 Purpose

The purpose of this document is to provide details about the system design of the Lifescan USB interface cable, herein after referred as LFS USB cable.

1.2 Scope

This document is intended to explain the design of LFS USB cable along with its software driver structure.

The software driver development and support are beyond the scope of LFS USB cable development. Software provided by the IC manufacturer shall be utilized.

1.3 Definitions, Acronyms and Abbreviations

Term/Acronym	Definition/Description
BGM	Blood Glucose Monitor
CMOS	Complementary Metal Oxide Semiconductor
USB	Universal Serial Bus
ESD	Electrostatic Discharge
IBM	International Business Machine
LFS	Lifescan
PC	Personal Computer
RS232	Serial Data Interface Standard
TTL	Transistor – Transistor Logic
UL	Underwriters Laboratories
OS	Operating System
IC	Integrated Circuit

1.4 References

1) USB specifications version 1.1
2) Datasheets of IC PL2303 – Prolific USB to RS232 Bridge Controller.
3) Datasheets of SMBJ15C – Microsemi's Transient Voltage Suppressor
4) Datasheets of Kemet Capacitors.
5) Datasheets of ROHM' Thick film SMD Resistors.
6) Datasheets of Shogyo' 3.5mm Phone Plug.
7) JIS C 6560 Standards for concentric plugs and jacks.
8) System Requirement Document (Doc.ID: HCLPLFS002_SRD_001)
9) LFS-USBCable – Sch.PDF (Doc.ID: HCLPLFS002_SCH_001)
10) Datasheets of IC LM339 – Quad Voltage Comparators

2 Product Overview

The function of the LFS USB cable is to connect Lifescan BGMs with a 3 pin data port to an USB port of an IBM compatible PC, running ONE TOUCH software Ver 2.0, to permit electronic transport of data between the two.

The LFS USB cable is composed of an USB series A Plug with flexible shielded 4 core cable at one end and a 3.5mm miniature stereo phone plug with flexible shielded 3 core cable at the other end. An embedded electronics is placed near the USB plug end of the cable that provides protocol and logic level translation between USB and Serial interfaces at TTL/CMOS level.

Power for the embedded electronics is derived from the host PC's USB port.

3 Project Objective

The major objectives of this project are the following:

?? To develop a cost effective high performance USB interface cable for Lifescan BGMs.

?? The LFS USB to serial converter PCB should have a form factor, small enough to be accommodated inside a small plastic hood.

4 Specifications

4.1 Functional

The LFS USB cable is an USB to Serial Interface converter cable that allows communication between a LFS BGM and an IBM compatible PC through USB port.

The LFS USB cable allows configuration of BGM meter settings with the help of One Touch software running in the PC and it allows downloading the data from the BGM to the PC.

4.2 Electro-mechanical

?? The total length of the LFS USB cable is 72 inches including the connectors.

?? Two types of cable are used in design. The cable between USB series A plug and PCB over mould is made up of 4 cores (for VCC, D+, D- and Ground signals) wrapped by an aluminium foil, a tinned copper drain wire and an interwoven braided outer shield, with other electro-mechanical parameters compliant to USB Ver 1.1 specifications.

- The cable between 3 pin stereo phone plug and PCB over mould is made up of 3 cores (for separate Transmit, Receive and Ground Signals) with a drain wire wrapped by an aluminium foil.

- The thickness of each core is chosen as 26 AWG to provide flexibility to the cable and to comply with the design requirement and applicable standards like UL444.

- PCB over mould is located near the USB plug end(at about 2 feet from USB plug) of the cable, which provides protocol conversion between USB and Serial interfaces.

- The maximum baud rate of the LFS USB cable is 57.6K and shall operate in full duplex mode.

5 Architecture

The PCB of the LFS USB cable comprises mainly of a single chip that provides protocol level conversion between USB and RS232 Serial interfaces at TTL/CMOS level. The selection of IC and its associated components for the USB to Serial conversion logic was accomplished after a detailed survey of the existing technology, features, cost and analysis of the system requirement of LFS. The hardware and software design is discussed in detail below.

5.1 Hardware

Following components were selected for the design.

The most critical component in the design is the USB to RS232 Bridge IC.

- **USB to RS232 Bridge:** IC **PL-2303** has been selected for this purpose. This IC is developed and manufactured by Prolific Technologies, Taiwan: Prolific and the IC are listed at http://www.usb.org . Listing in USB.Org ensures 100 % compliance to USB specifications(V1.1). The PL-2303 USB-to-Serial Bridge Controller is a low cost device that provides high performance single chip solution for the protocol translation. It operates as a bridge between an USB and Serial Interface at TTL/CMOS level. The two large on-chip buffers accommodate the data flow from two different interfaces.

  The USB bulk-type data is adopted for maximum data transfer. Automatic handshake is supported at the serial interface. This device along with its associated software driver enables USB interface to be transparent to the peripherals and allows BGMs to connect to USB port.

  This IC is fully compliant with USB specification V1.1. It also supports EIA RS232 serial communication. It utilizes bus powered technology (i.e. it takes power for its operation from USB port of PC.) and operates at full speed as per USB spec. version 1.1(12Mbps between USB port of IC and host PC).

- **Voltage Comparator:** A Quad voltage comparator, IC LM339 is used in each TXD and RXD line to prevent back drive voltage from BGM that appear on the USB lines. I/O pins of unused comparators are properly terminated with negative feedback.

- **Crystal:** 12MHz crystal has been selected as per recommendation by IC manufacturer. This crystal is used as a master clock for all applications. A metal cap is provided over the crystal to protect it under high pressure and temperature during molding process.

- **Capacitors:** Six 0.1uF ceramic capacitors and two 10uF tantalum capacitors are used as decoupling capacitors for filtering noise in the power lines. Two 30pF ceramic capacitors are used as load capacitors for clock frequency stability as recommended by crystal manufacturer.

- **Resistors:** A 220K resistor is used as a pull-up for input pin TRI_MODE of IC, which is used to select tristate control of RS232 lines during suspend mode of USB interface.

  Another 220K resistor is used as a pull-down resistor for input pin LD_MODE of IC, which is used to select light load (< =100mA) operation. This meets the USB V1.1 power draw limit specification of < =100 mA.

  A 1.5K resistor is used as 3.3V pull-up on data line D+ as per USB spec. version 1.1 to indicate the remote host that the device can operate at full speed (data rate between USB port of IC and PC is 12Mbps).

  Two 27E resistors are used as source terminating resistors in data lines (D+, D-). These are required for high speed signal lines to avoid any noise that may occur due to the reflection of signals.

  Two 4.7K resistors are used as Pull up for EE_CLK and EE_DATA lines of IC PL-2303 as recommended by IC manufacturer.

  Two 10E resistors, one each in TXD and RXD lines (in series) are used to improve ESD immunity

  Two 10M resistors are used as weak pull down in Non-inverting input terminal of comparator to avoid open circuit condition when meter is not connected to LFS USB cable.

  One 12K and one 36K resistors are used as voltage divider resistors to generate reference voltage for the comparators present in TXD and RXD line, Vref is applied in Inverting input terminal. High values of resistors are chosen to limit the current (in the order of Micro Amps) drawn from USB port. Under ideal conditions the reference voltage is 1.25 V and can vary from 1.01V to 1.42V depending on the Vcc and tolerances of resistor. Under ideal conditions, any voltage above 1.25V will be interpreted as Vhigh and any voltage below 1.25V will be interpreted as Vlow. The idea behind choosing 1.25V is that the meters can operate at low voltages upto

2.15V. This can present a voltage of 1.9V on the line. Weak batteries can produce further low values. The cable will operate reasonably even below the required voltage levels.

One 15K resistor is used as pull up in open collector output terminal of comparator in RXD line. One 820E resistor is used as pull up in open collector output terminal of the comparator in TXD line. The reason for choosing 820 ohms is to ensure a volatage close to 3.5V when OT Surestep meter is connected which offers 3K loading on the line.

- **Diode:** One diode is connected in series with pull up resistor in TXD line to prevent back drive voltage in TXD line. The back drop voltage through RXD line will be avoided by comparator which is powered by USB port.

- **Transient Voltage suppressors:** Two transient voltage suppressors are placed in each of Transmit (TXD) and Receive (RXD) lines at the serial communication end, which are used to protect the circuit from ESD of upto ± 15KV.

- **Ferrite Cores:** Two ferrite cores are added on either side of PCB overmold to suppress EMI noise.

5.2 Software Driver

5.2.1 Functional

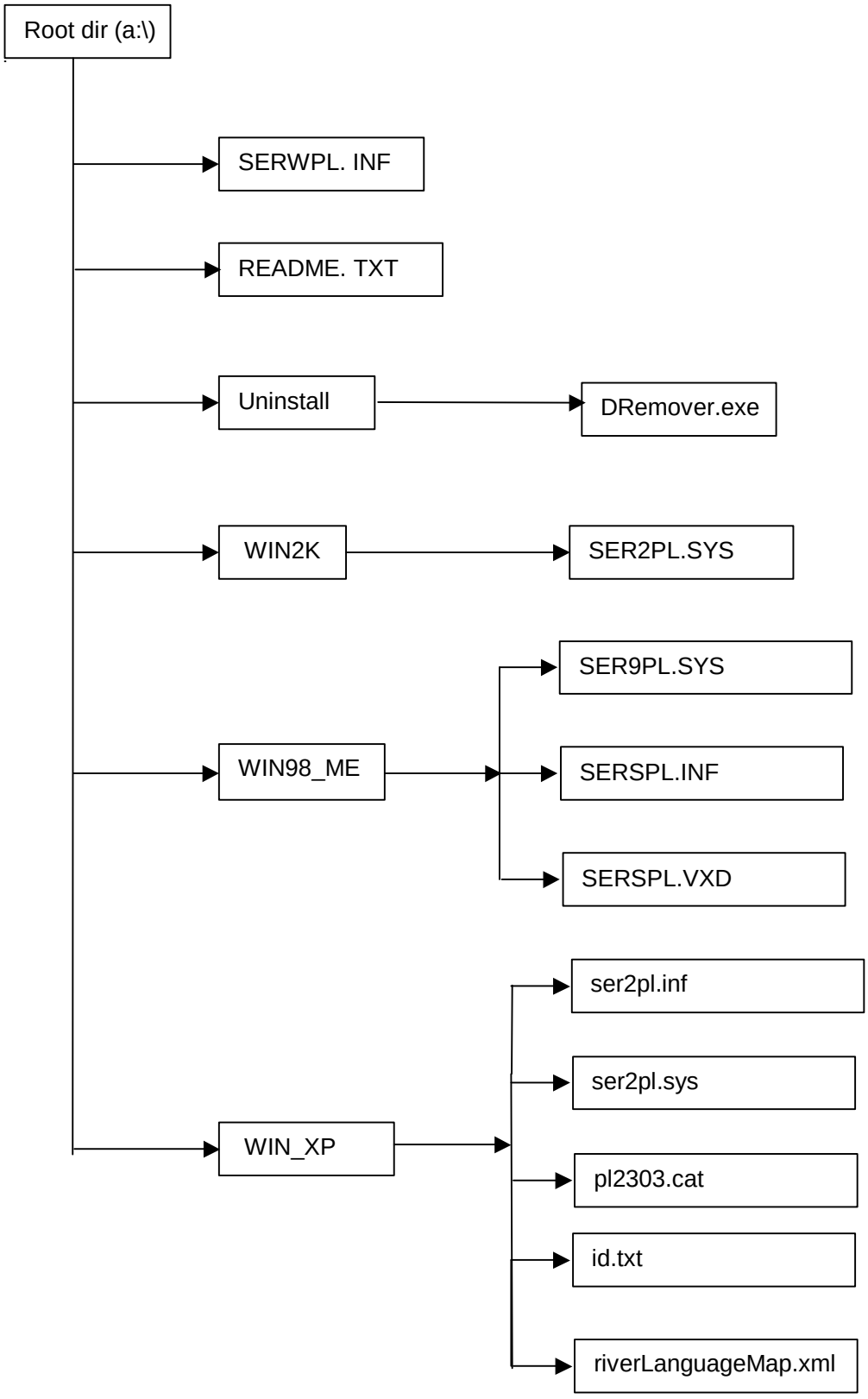
The software driver has been developed by the IC manufacturer, Prolific. It is used to emulate the USB port of PC as a virtual COM Port. Once the driver is installed, the respective USB port in which the cable is plugged in is mapped to unused COM port of PC. With the help of this virtual COM port emulation, BGMs can communicate to the PC through its USB port without making any change in the One Touch software.

Once the driver emulates the USB port as a Virtual COM Port, all the configurations in the original COM Port are applicable to the Virtual COM Port also.

This driver is freeware available from Prolific for users of their USB to RS232 Bridge IC (PL2303). The driver can be downloaded from Prolific's website at http://www.prolific.com.tw.

After downloading the software for the different Operating Systems, the software is stored in the directory structure provided below. This directory structure when stored on a media like a floppy disk, allows easy installation of the driver on all supported Operating Systems.

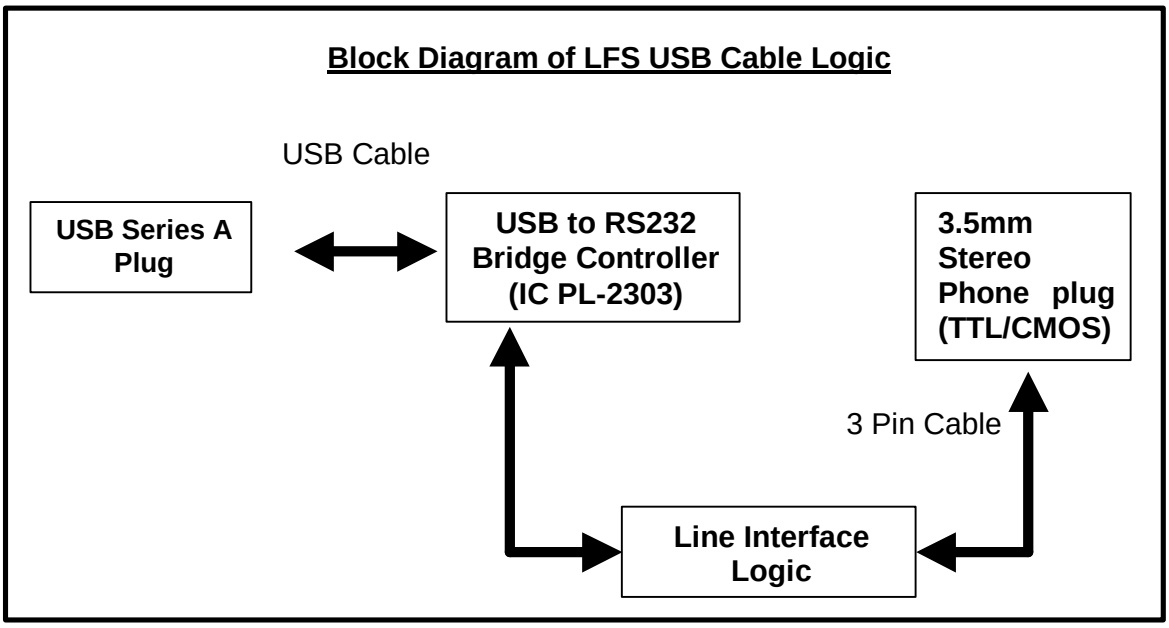
5.2.2 Directory structure of Software Driver



6 Design Implementation

6.1 Design description

LFS-USBCable – Sch.PDF: This schematic sheet provides the overview logic of the LFS USB Cable. The major building blocks are the USB connector, an USB to RS232 bridge controller, Line interface logic and a 3.5mm stereo phone plug.



The detail function of each block is as follows:

USB Series A Plug: This connector is an Industry standard USB connector. The pin details of USB series A plug are as follows:

Contact Number	Signal Name	Typical color of the cable core
1	VBUS	Red
2	D-	White
3	D+	Green
4	GND	Black
Shell	Drain Wire	-

The function of this USB Plug is to mate with the USB Port of PC and provide physical link between PC and PCB.

USB to Serial Bridge Controller: IC PL2303 is used for USB to Serial conversion. The main function of this controller is to provide protocol and logic level conversion between USB and Serial interfaces at TTL/CMOS level.

Line Interface Logic: A Voltage comparator, IC LM339 is used for this purpose. This logic is added at the serial interface side to prevent the back drive voltage from BGM that appear on the USB power and signal lines when BGM meter is connected to the USB interface cable. The back drive voltage from any device to the USB upstream facing port is not accepted as per USB Specifications.

3.5mm Phone plug: This is a Industry standard 3.5mm diameter 3-pin plug used to connect to 3-pin data port of LFS BGM meters. The tip of the plug transmits the data from PC and the ring of the plug receives the data from LFS BGM. The sleeve of the phone plug is connected to the logic ground of the BGM. The shield of the cable floats at the meter-end and is connected to the shell of the GND on Logic PCB.

Pin Name	Pin Description
Tip	Transmit Data (TXD) - output from PC
Ring	Receive Data (RXD) - input to PC
Sleeve	Ground (GND) -Common Ground

LifeScan USB Cable — **Bill of Materials**

HCL Peripherals (A Unit of HCL Infosystems Ltd.)

Bill Of Materials | Rev. B | Product Code: 829 | Sub-Assy. Code: 59724 | Doc. ID: HCLPLFS002_BOM_001

Item	SS.No.	Description	Quantity	Reference	Package	Vendor/s	Part Number/s	Contact Address1	Contact Address2
1	10139	**IC PL-2303, USB-Serial Bridge Controller, 28 pins SSOP package**	1	U1	28 pins SSOP	Prolific Technology Inc.	PL-2303H	Prolific Technology Inc. 7F, No.48, Sec. 3, Nan Kang Rd.,Nan Kang, Taipei, Taiwan 115, R.O.C. Tel: +886-2-2654-6363 Fax: +886-2-2654-6161	Prolific Technology Inc. 27R, 5F, Bldg. 52, 195-20 Sec.4, Chung Hsing Rd., Chutung, Hsinchu, Taiwan 310, R.O.C. Tel: +886-3-583-2798 Fax: +886-3-583-2796
2	10140	**Capacitor Tantalum 10uF, +/-20%, 20V/25V, Case C**	2	C1, C2	Case C	Kemet	T491C106M025AS	KEMET Electronics Corporation 26 Corporate Plaza, Suite 170 Newport Beach, CA 92660 Tel: 949-640-9320 Fax: 949-720-9807	KEMET Electronics Corporation 2350 Mission College Blvd., Suite 390 Santa Clara, CA 95054 Tel: 408-986-0424 Fax: 408-986-1442
						AVX	TPSC106M025R500 (or) TAJC106M025R (or) TAJC106M020RBJ		
						Vishay Sprague	593D106X0025C2T (or) 293D106X0025C2T		
						Panasonic-ECG	ECSH1DC106R		
3	10141	**Capacitor Ceramic 0.1uF/50V**	6	C3 - C8	0805	Kemet	C0805C104M5RAC	KEMET Electronics Corporation 26 Corporate Plaza, Suite 170 Newport Beach, CA 92660 Tel: 949-640-9320 Fax: 949-720-9807	KEMET Electronics Corporation 2350 Mission College Blvd., Suite 390 Santa Clara, CA 95054 Tel: 408-986-0424 Fax: 408-986-1442
						AVX	08055C104MAT2A		
						Vishay Sprague	VJ0805Y104MXAAT		
						BC Components	0805B104M500BT		
						TDK	C2012X7R1H104MT		
4	10142	**Capacitor Ceramic 30pF/50V, 0805, NPO,+/-5%**	2	C9, C10	0805	Kemet	C0805C300J5GAC	KEMET Electronics Corporation 26 Corporate Plaza, Suite 170 Newport Beach, CA 92660 Tel: 949-640-9320 Fax: 949-720-9807	KEMET Electronics Corporation 2350 Mission College Blvd., Suite 390 Santa Clara, CA 95054 Tel: 408-986-0424 Fax: 408-986-1442
						AVX	08055A300JAT2A		
						Vishay Sprague	VJ0805A300JXAAT		
						TDK	C2012COG1H300JT		
						BC Components	225204341309		
5	10143	**Resistor CF 220K, 1/8W, 0805**	2	R1, R2	0805	ROHM	MCR10EZHJ224	ROHM Electronics 10145 Pacific Heights Blvd. Suite 1000 San Diego, CA 92121 Tel: (858) 625-3630 Fax: (858) 625-3670	
						EUROHM/Anglia	RW224		
						AVX	CR21-224J-T		
						PhyComp	232273061224		
						BC Components	DCU08055%PA220K		
6	10156	**Resistor CF 1K5, 1/8W, 0805,**	1	R3	0805	ROHM	MCR10EZHJ152	ROHM Electronics 10145 Pacific Heights Blvd. Suite 1000 San Diego, CA 92121 Tel: (858) 625-3630 Fax: (858) 625-3670	
						EUROHM/Anglia	RW152		
						AVX	CR21-152J-T		
						PhyComp	232273061152		
						BC Components	DCU08055%PA1K5		

						ROHM	MCR10EZHF270	ROHM Electronics 10145 Pacific Heights Blvd. Suite 1000 San Diego, CA 92121 Tel: (858) 625-3630 Fax: (858) 625-3670	
						EUROHM/Anglia	RK270		
						AVX	CR21-270F-T		
						PhyComp	232273462709		
7	10157	**Resistor MF 27E, 1/8W, 0805,**	2	R4, R5	0805	BC Components	DCU08051%PA27E (or) 231232472709		
						ROHM	MCR10EZHJ472	ROHM Electronics 10145 Pacific Heights Blvd. Suite 1000 San Diego, CA 92121 Tel: (858) 625-3630 Fax: (858) 625-3670	
						EUROHM/Anglia	RW472		
						AVX	CR21-472J-T		
						PhyComp	232273061472		
8	10165	**Resistor CF 4K7, 1/8W, 0805,**	2	R6, R7	0805	BC Components	DCU08055%PA4K7		
						ROHM	MCR10EZHJ100	ROHM Electronics 10145 Pacific Heights Blvd. Suite 1000 San Diego, CA 92121 Tel: (858) 625-3630 Fax: (858) 625-3670	
						EUROHM/Anglia	RW100		
						AVX	CR21-100J-T		
						PhyComp	232273061100		
9	4396	**Resistor CF 10E, 1/8W, 0805,**	2	R8, R9	0805	BC Components	DCU08055%PA100		
10	10241	**Comparator, 14 pins SO package**	1	U2	14 pins SO	ST Microelectronics	LM339DT	http://www.st.com	
						ROHM	MCR10EZHJ106		
						EUROHM/Anglia	RW106		
						AVX	CR21-106J-T		
						PhyComp	232273061106		
11	10235	**Resistor CF 10M, 1/8W, 0805,**	2	R11, R13	0805	BC Components	231232411006		
						ROHM	MCR10EZHJ153		
						EUROHM/Anglia	RW153		
						AVX	CR21-153J-T		
						PhyComp	232273061153		
12	10236	**Resistor CF 15K, 1/8W, 0805,**	1	R12	0805	BC Components	231232411503		
						ROHM	MCR10EZHJ363		
						EUROHM/Anglia	RW363		
						AVX	CR21-363J-T		
						PhyComp	232273061363		
13	10237	**Resistor CF 36K, 1/8W, 0805,**	1	R14	0805	BC Components	231232413603		
						ROHM	MCR10EZHJ123		
						EUROHM/Anglia	RW123		
						AVX	CR21-123J-T		
						PhyComp	232273061123		
14	10238	**Resistor CF 12K, 1/8W, 0805,**	1	R15	0805	BC Components	231232411203		
						ROHM	MCR10EZHJ821		
						EUROHM/Anglia	RW821		
						AVX	CR21-821J-T		
						PhyComp	232273061821		
15	10239	**Resistor CF 820E, 1/8W, 0805,**	1	R10	0805	BC Components	231232418201		

16	10240	**Diode 1N4148, SOD-123 packa**	1	D1	SOD-123	Diodes Inc.	1N4148W-7	http://www.diodes.com	
						Vishay Semiconductors (formerly General Semiconductor)	SMBJ15C	Vishay Americas, Inc. One Greenwich Place Shelton, Connecticut 06484 USA Tel: 1 - 402 - 563 6866 Fax: 1 - 402 - 563 6296	
17	2342	**Tranzorb - Transient Voltage**	2	TZ1, TZ2	SMD	Mircosemi	SMBJ15C	Microsemi Corporation 23F, 105 Tun Hwa S. Road, Sec. 2, Taipei 106, Taiwan Ph.:+886 (2) 2755-0000 Fax: +886 (2) 2784-1668	
18	10158	**Connector USB Series 'A' Plug**	1	P1	Straight Plug type	Comoss Electronic Co. Ltd.	USB-4MASS05TW	Comoss Electronic Co., Ltd., 4F, No.11, Chung-Hsin St., Shulin Taipei 238, Taiwan, Ph.:+886 2 2688 2498 Fax:+886 2 2689 9160	
						Fuan Gee, Taiwan	P3261	Fuan Gee Mechanical Industrial Co., Ltd No. 12, Lane 147, Tung Jung St., Shu Lin Chen, Taipei, Taiwan ROC Tel. +886-2- 86862780	
19	10010	**Phoneplug 3.5mm (STEREO)**	1	JP1	Straight Plug type	Win Connectors	BDC-0210		
						Ecliptek	EC1-30-12.000M-I2 TR	Ecliptek Corporation 3545-B Cadillac Avenue Costa Mesa, California 92626 USA	
20	10159	**Crystal 12MHz, Fundamental, Series Resonance, +/-100PPM, Height=2.5mm, Load Cap.=30pF with insulation pad**	1	X1	Ultra low profile	Fronter	FTX12M30S1 with Insulation Pad	Fronter Electronics Co., Ltd., Rm.906,9/F.,Chuangzhan Center, No.6007, Shennan Rd., Shenzhen, China, 518040. Fax: 86-755-83867976 Tel: 86-755-83867990	
						Hi-Q Electronics, India		Hi-Q Electroncis Pvt. Ltd., Plot 9, Industrial Estate Hosur-635109, Tamil Nadu Tel: +91-4344-542911	
21	10160	**PCB "LFSUSB-B", Area:38mm x 20mm, +/-0.5, 4 Layer, 1.6mm Thickness, UL mark**	1			Excel Circuits, India		Excel Circuits Pvt. Ltd. 40A, Jigani Industrial Area Anekal Taluk, Bangalore. Tel: +91-08110-25560,08110-25370 Fax: 91-80-6612790	
						Hitachi Shin Din Cable Ltd., Hong Kong.	SPH-11-0252A	Hitachi Shin Din Cable Ltd., Unit 41010-11, 41/F., Metroplaza Tower 1, 223 Hing Fong Road, Kwai Fong, N.T. Hong Kong. Tel.: 852-27410121 Fax.:852-27854021	
						Comoss Electronic Co. Ltd.	A0501147		
						Space Shuttle Hi-Tech Co., Ltd.	12B730BCF645D6		
						Evernew Wire & Cable Co. Ltd, Taiwan	UL4443C26-1		
22	10161	**Cable wire 3 core, 26AWG stranded with shield, UL, PMS430C - 48 inches**	1			Avon Data Cables Pvt. Ltd. India	UL4443C26-1		
						Comoss Electronic Co. Ltd.	A0514015		

						Space Shuttle Hi-Tech Co., Ltd.	KDHC402K3645790	Space Shuttle Hi-Tech Co., Ltd. 226, Wu-Ho St., Wu-Lung Village, Chiung-Lin Hsiang, Hsinchu Hsien,Taiwan Tel: 886-3-5935588 Fax: 886-3-5935566	
23	10162	**Cable wire 4 core for USB, 28/26AWG stranded with shield, UL, PMS430C - 24 inches**	1			Hitachi Shin Din Cable Ltd., Hong Kong.	SPH-11-0251A	Hitachi Shin Din Cable Ltd., Unit 41010-11, 41/F., Metroplaza Tower 1, 223 Hing Fong Road, Kwai Fong, N.T. Hong Kong. Tel.: 852-27410121 Fax.:852-27854021	
						Comoss Electronic Co. Ltd.	A0902026		
						Evernew Wire & Cable Co. Ltd., Taiwan	PVCPMS430C-1	Evernew Wire & Cable Co. Ltd., 5F,No,111,Keelung. Rd., Sec.2, Taipei, Taiwan,R.O.C. Ph.: 886-2-2738-6662 Fax: 886-2-2738-5266	
24	10102	**PVC granules for outer mold, UL Grade, 75 deg. C, Colour: PMS430C**	55g			Chia Shin Enterprises Co.Ltd., Taiwan	PVC91155	Chia Shin Enterprises Co., Ltd. 20 Alley 3, Lane 11 Yah Chou Rd., Tu Cheng City, Taipei, Taiwan.	
25	10198	**Metal Cap, GI / CRCA, 0.6mm thick, for enclosing Crystal**	1			HCL Peripherals, India.	R0829-PR-001-00		
26	10103	**LDPE /HDPE granules for inner mold**	40g			Indian Petrochemicals Corporation Ltd.	LDPE Grade: 16MA400 HDPE Grade: HD50MA180	Indian Petrochemicals Corporation Ltd. 9th Floor, Air India Building, Nariman Point, Mumbai - 400 021, INDIA. Phone (W): +91-22-202 7479 Fax (W): +91-22-282 0508	
27	10249	**Ferrite Core - K5B RH 14.2x28.5x6.35**	2	One each on either side of PCB overmold		King Core Electronics Inc.	PS14211A	King Core Electronics Inc. No.158,Yang Hsin Rd., Sec.2,Yang Mei Chen, Tao Yuan Hsien, Taiwan R.O.C Tel : 886-3-4782511(Rep.) Fax : 886-3-4759923 email : kc@mail.kingcore.com.tw	

Note:
1.Cost of Plastic Mould tool is extra and will be billed at actuals.
2.All specified tolerances are maximum values.Lesser tolerance components can also be used.

Project Name	Document Name	Project Code	Document ID & Rev.No.	Author Name	Author Signature	Effective Date
Lifescan USB Cable	Bill of Materials	HCLP-LFS-002	HCLPLFS002_BOM_001 Rev.B	S.Dhanapal		

Sl.No.	Internal Reviewer Name	Department	Approval	Date	Remarks
1	S.T.Marban	R & D			
2	R.Bala Murugan	IV&V, HCLT			
4	R.Sheymala	QC, HCL PD			

Sl.No.	External Reviewer Name (Client)	Department	Approval	Date	Remarks
1	D.Hernandez	Operations			